Journal of Research Practice, Volume 3, Issue 2, 2007

Journal of Research Practice
Volume 3, Issue 2, Article M20, 2007

ISSN: 1712-851X

Main Article:

Synecdoche and Surprise: Transdisciplinary Knowledge Production

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Abstract

Using contemporary insights from feminist critical theory and the literary device of synecdoche, we argue that transdisciplinary knowledge is productive because it maximizes serendipity. We draw on student learning experiences in a course on "Gender and Science" to illustrate how the dichotomous frameworks and part-whole correspondences that are predominant in much disciplinary discourse must be dismantled for innovative intellectual work to take place. In such a process, disciplinary presumptions interrogate and unsettle one another to produce novel questions and answers.

Keywords: knowledge production; interdisciplinary; transdisciplinary; humanities; science education; feminism; feminist theory; haiku; literary theory; physics

Suggested Citation: Dalke, A., & McCormack, E. F. (2007). Synecdoche and surprise: Transdisciplinary knowledge production. *Journal of Research Practice, 3*(2), Article M20. Retrieved [date of access], from http://jrp.icaap.org/index.php/jrp/article/view/106/99

1. Making Room for Surprise

> Acknowledging the agency of the world . . . makes room for . . . the world's independent sense of humor. . . . Feminist objectivity makes room for surprises and ironies at the heart of all knowledge production; we are not in charge of the world. (Haraway, 1988, pp. 593-594)

The call for papers for this special issue identified "a mismatch between our current inherited structures for organizing knowledge (the combination of conceptual, methodological, and institutional forms that comprise disciplines)," and transdisciplinary ways of pursuing new knowledge. We are responding to that call with an examination of the multifaceted relationship that exists between the observations we make of the world and the generalizations we make based on those observations. We offer here a perspective on how knowledge gets generated in transdisciplinary transactions, one that rests neither on singular relations between various parts, nor on a presumed congruence between parts and wholes.

We write out of our experiences as faculty members at a small liberal arts college in the USA; one of us is a molecular physicist, the other a feminist literary theorist. Ten years ago we taught together a first-semester writing seminar; we have just finished co-teaching a second course on gender and science. As we moved from teaching composition to first-year students to exploring ontological, epistemological, and methodological claims with more advanced undergraduates, we acquired a way to think about knowledge production that highlights both the settled quality of disciplinary frameworks and the productively unpredictable effect of putting them into conversation with one another.

Our thinking about this conversation draws on three sources: one theoretical, one experiential, one symbolic. The first is the contemporary feminist critique of the conviction that "the natural sciences can produce impartial, disinterested, value-neutral accounts of a nature completely separate from human history" (Harding, 1991, p. 81). The second is our recent experiment of putting such theories into play with eight upper-level students in a class on "Gender and Science" at Bryn Mawr College, USA, during the academic year 2006-2007. Our third source is the concept of *synecdoche*, which is both specific to the discipline of literary studies and more generally useful as an image of the underdetermined relationship between parts and their wholes.

Drawing on these three sources, we argue that a key component of transdisciplinary knowledge production is that it foregrounds the shattering of conventional wholes. Transdisciplinarity highlights the inadequacy of one-to-one correspondences between paired concepts, and demonstrates that parts and wholes are not necessarily congruent. Accordingly, the moves between them will always be underdetermined, and the results of those moves always a surprise.

2. Meeting the Universe Halfway

> Nature has agency, but it does not speak itself. . . . There is an important asymmetry. . . . we do the representing. (Barad, 1996, p. 181)

When we designed our course on "Reenvisioning & Revising the Relation Between Gender and Science," we used the field of quantum mechanics as exemplar, and contemporary novels and films as imaginative test cases. Our defining idea was the presumption of congruence between the epistemological implications of modern physics and feminist critiques of the longstanding

"inability of Western knowledges to conceive their own processes of material production" (Grosz, 1993, p. 196).

Learning from a molecular physicist about the ways in which our measurements of probabilistic, nondeterminant phenomena are influenced, both conceptually and physically, by our observations, our students began to recognize the degree to which *feminist standpoint epistemologies* correspond to the insights of modern physics (Harding, 1986, p. 141). Our role as observers makes us part of the experiment and therefore part of the measurement, not just a perturbation, but a determinant in phenomenological outcome:

> We cannot avoid the condition of our participation. . . . in Heisenberg's words, "the scientific method of analyzing, [defining] and classifying has become conscious . . . that by its intervention science alters and refashions the object of investigation." (Lukacs, 1994/2001, p. 230)

Throughout the semester, we interspersed explanations of contemporary quantum theory with texts that included accounts of Keller's *dynamic objectivity* (1985), Haraway's *situated knowledges* (1988), Longino's *contextual empiricism* (1990), Harding's *strong objectivity* (1991), and Barad's *agential realism* (1996). These forms of *nonrelativist constructivism* are all congruent with the understandings of quantum mechanics; they are also critical of commonly held notions of both identity and science. They are central, too, to the sorts of scientific and political agency that the intersection of science and feminist theory both encourages and enables.

As we explored this material together, we realized that we were two *second-wave* feminists, finding repeated correction in the minds, and at the hands, of our *third-wave* students. These young women persistently recognized the fundamental ambiguities inherent in our terms and categories (for a survey of the different "waves" of feminism, see Tong, 1998). The students were thereby demonstrating that "knowledges are not innocent representations, but intra-actions of natures-cultures" (Barad, 1996, p. 189). The unpredictable outcomes of such intra-actions helped us to understand why and how transdisciplinary work can be so generative of new ideas.

3. Breaking the Binary

Our students' interventions repeatedly altered the terms around which we had structured our conversations. We highlight here only the first instance of what soon became a persistent pattern. We opened the initial class by inviting our students to describe, sequentially, their experiences of being scientists, of being women, and of being women scientists: What were the physical objects and activities they associated with each of these experiences? What, in each case, were their interactions with and manipulations of the world? What were the physical and intellectual attributes of each? How did the experiences of being a scientist and being a woman resemble and differ from one another?

The paired options we had so carefully used to construct this exercise broke down very quickly.

We had intended to contrast the historical, stereotypical "or" relationship between the categories "woman" and "scientist" with the "and" relation indicated in our course title and conception. But it became quite clear, before we had finished even the first round of responses, that the simplicity of the binary connectors ("and" and "or") was not going to encompass either our students' experiences or their reflections on them.

A social science major refused the category "scientist." A transgender student refused the category "woman." An independent major in Gender and Sexuality refused to acknowledge a boundary between science and politics: "the very act of finding things out can itself be a political act," she wrote in the course forum; "choosing what questions to ask in science and what is important enough to be funded are social, political, as well as scientific decisions."

Under the tutelage of such students, we soon realized how ironic it was that we had designed a third-wave interdisciplinary course around a second-wave disciplinary practice of *dualistic* knowledge frames. Our students' questions and new observations repeatedly shattered any dualistic sense-making. Adding a variety of perspectives and new dimensions, the students refused one-to-one-correspondences between paired concepts. They repeatedly broke "dualisms, binary oppositions, dichotomies, and other demarcations" (Barad, 1996, p. 163). The collision of our paired constructions with our students' real world diversities gave rise to multiple manifestations, far more complex than the dichotomous structures within which we had framed the course.

4. Questioning the Congruence

Our students not only disrupted our dualistic constructions; they also showed us how selective our mapping techniques were, how underdetermined were our moves from part to whole. For example, they repeatedly critiqued any simple correlation between the activities of collecting, organizing, and analyzing data, and what they were willing to identify as the practice of science. The second day of class, for instance, we were discussing a dialogue that claimed to explain "the science behind the relation between gender and science" (Pinker & Spelke, 2005). The students immediately put the category "science" itself under interrogation, refusing it the status of a bounded and knowable object. How can you tell when it is a *scientist* talking? How do you adjudicate when scientists offer different interpretations of the same data? What role does gender play, in the different positions taken by different scientists? What differentiates a moral from an empirical claim? Can the truth be sexist?

A later discussion focused on an essay by Evelyn Fox Keller on "Cognitive Repression in Contemporary Physics" (1985) and another by Sandra Harding on "Why 'Physics' is a Bad Model for Physics" (1991). The students then expanded further on the problems encountered in attributing a correspondence between society (the whole) and science (a part within it). One student strongly endorsed Harding's claim that "the model for good science should be research programs explicitly directed by liberatory political goals" (Harding, 1991, p. 98). She argued in

the course forum that “science research and development . . . must be refocused so that the lives of less advantaged people, who are the majority, will be benefited.”

Another student took a counter-position, arguing that a pursuit of “pure science” was likely to be more productive, if not bound either to specific social goals or to the hubris of thinking that we can predict what will happen. A third student broke the symmetry of this opposition, by suggesting, first, that science exists not in opposition to society, but as part of it; second, that the relationship between part and whole was neither simple or harmonious. She reminded us of the “long, sad history” of using “social value” as a standard from which to judge and fund the work of science. As an example, we considered Stephen Jay Gould’s critique of *biological determinism* in *The Mismeasure of Man* (1986): how reliance on physical brain size as a measure of intelligence and human worth was used to support perpetuate social and economic differences.

But perhaps the most delightful illustration of our students’ challenge to the presumed congruence of parts and wholes was an essay in which a physics major traced the process of writing a haiku, a minimalist form of poetry of Japanese origin. We include the essay in full in the following section, because it so well demonstrates the revisability inherent in the *reciprocal loop* between words and the large range of their possible allusions, associations, and meanings (Dalke, Grobstein, McCormack, 2006). None of the word choices that went into making the haiku was predictable before it was made, nor were the range of associations evoked by each word knowable ahead of time.

5. “Apple Blossom Journey: A Path to Feminizing Physics”--An Essay by Megan Stegall

> I remembered the joke I’d made in class . . . that a single haiku wouldn’t exactly equate to five pages of writing.
>
> That was, perhaps, untrue. I also remembered what [one of my professors] had said in reply, that a haiku filled with words of the right weight could in that sense perfectly fit the bill. All this remembering happened as I was walking across campus, and simultaneously thinking about how I’m really going to miss the weeping cherry trees when I graduate.
>
> *Cherry blossoms fall*
> *Gently back to their mother*
> *Female gravity*
>
> Well, how’s that? Does it weigh enough? Somehow it didn’t feel right (how much of writing is feeling, and how much thinking? I mean, if we’re bodied individuals and not just floating intellectualism . . .) and I decided to play with it. The first thing that occurred to me was that it would be more potent for this case to speak of apple blossoms, since--although it was the cherry trees that inspired me--it was allegedly an apple that inspired Sir Isaac Newton.
>
> I had written this short poem down in a little notebook I carry, since I was headed off on the bus to a class . . . and knew that I wouldn’t remember it on my own. So I

reopened my notebook and wrote, below the first one, a slightly different version, playing with some more of the words.

Apple blossoms drift
Gently down to their mother
Female gravity

Still not quite right. I liked the apple--makes me think simultaneously of Sir Newton and Eve, since it was her famous fruit, too, and I learned both their stories in early childhood. “Drift” wasn’t right, though, as it implied a purposelessness I couldn’t identify with. “Fall” was better, it seemed, both because of the Eve reference and because fall is, of course, the season of harvest, which feels traditionally feminine to me. I guess I’m thinking of all those Earth-Mother goddess types and the classical image of my own zodiac sign, Virgo, as a woman holding a sheaf of grain or wheat.

I also was now no longer sure about “gently.” Most of the women I know I would not describe as gentle, although I’m aware it’s a stereotype of women. I think "graceful" is more appropriate, both for the motion of the flowers and for the women I know. I also like this word because it feels closer in meaning to "elegant," which (while not the best description of homey, comfortable apple blossoms, I think) is a term we often use in physics to describe mathematics . . . and which we use in the rest of the world to describe women.

Apple blossoms fall
Graceful down to their mother . . .

Now I’m starting to have issues with “down” and “mother,” since I don’t want to associate this feminine motion with a lowering or moving down (hierarchy?), and “gravity” may have done that already, and I’m intensely aware of the masculine critique that a feminizing of physics might lose some of the mathematical rigor for which physics is famous. I don’t want to sound too . . . well, too much like a math-phobic hippie, so to speak, a stereotype I’ve also fought. Anyway, thinking about the physicist’s use of "elegant" made me want to use something distinctively mathematical in this poem, and since I know gravity makes objects move in interesting parabolic shapes, I rewrite the second line.

Apple blossoms fall
Graceful wind parabolas
Female gravity

To be honest I got the word “wind” just by needing one more syllable for that line . . . but I’m starting to really like it, because it means both the breeze pushing the blossoms, which leads to a more complex motion, and because it could indicate that motion itself, in a spiral, winding kind of way. In fact, I’ll keep it because of that dualism on the page, because any empirical data can and must be interpreted from more than one perspective for understanding. Plus, of course, the complexity of motion influenced by both gravity and friction from wind implies a more holistic understanding of motion--no one-dimensional ball-dropping here!

I like parabolas here--they’re one of the most simple and familiar non-linear functions in math, and one of the first things one learns in any algebra or precalculus math class; so they’re very accessible, but since they do really describe the motion of an object influenced by gravity, they are also very important to classical mechanics. They are, in that way, both fundamental and far-reaching.

Now that last line is beginning to bother me. It’s too confining--for a poem that touches on Newton and Eve, simplicity (haiku) and complexity (holistic motion),

> duplicity of meaning in a single word, and the vast functionality of a single function (math function, that is, the parabola), I don't want to limit myself to gravity. Let's try physics, with a syllable change.
>
> *Apple blossoms fall*
> *Graceful wind parabolas*
> *Feminine physics*
>
> I like that better. The more I read it, the more I dwell on it, the more I see in it. Apples for Isaac and Eve, for knowledge either given mysteriously (by God?) or taken, maybe without knowing the consequences but daring to ask anyway. Blossoms for femininity--fragile perhaps, beautiful certainly, and terribly useful (reproduction, of course). Fall for Eve's fall, for autumn, maybe for the descent of physics from the top of that pyramid we deny so strongly, falling to a level where everyone can be equal.
>
> Grace is a woman's name; graceful a feminine adjective. Full of grace, perhaps another gift from God, perhaps just the inner peace that comes with communing with the universe as we see it, as we can understand and interact with it. Wind blows through those blossoms, which then wind their way to the earth, interacting and exchanging energy with the tiniest molecules of air. Beautiful parabolas erase the classic classroom examples of cannonballs and football players and replace it with something more primal, perhaps more real, than our weapons and games.
>
> Feminine physics. More complex, more holistic, more useful, more beautiful, more accessible than the kind of elite priesthood we have all encountered before. I really thought about simply submitting my final haiku as my paper, and while each of you might have read it through and through and through and thought about it and come to a unique, deep, rich understanding of its phenomenological meaning (because every word is a phenomenon in our agential perception, right?), that would have also been shutting you out of my process. It would have set me apart as The Author, another priesthood just as cut off from the world as physics can be. So I asked you to join me on my apple blossom journey, and add my meaning to your own to create a deeper, richer, wider understanding than I, or any Author, could come up with alone. (Stegall, 2007)

Stegall's essay is a narrative of how a haiku evolved: the history of its accidents becoming intentions, and of the revisions that emerged from that dynamic, as well as an account of a range of possible interpretations. In offering both poem and interpretation, the essay illustrates the unpredictability of the intellectual activity we have been framing here. It describes multiple serendipitous interactions and the surprising configurations that arise from them. It is unhesitating in expressing novel associations among parts, which lead, in turn, to new meanings of the whole. This dynamic continued in our responses to Stegall, in which we probed the limits of her word choices "graceful" and "feminine," insisting that the process not come to an end.

Other student essays were as varied as their disciplinary training, which ranged from anthropology through biology, gender studies, physics, and psychology. Laying these different lenses alongside one another and layering them atop one another had the effect of creating what Barad calls a "'diffractive' method of analysis": "not merely one of reflexivity, but rather . . . an exploration of the difference that different boundary-drawing practices make" (Barad, 1996, p. 189). Barad's own project highlights "different interpretations . . . as diffracted through different

understandings of science" (Barad, 2000, p. 245). Our diffractions and those of our students, arrived at by drawing on a range of perspectives from the social sciences and humanities, revealed provocative multidimensional patterns of knowledge.

6. Synecdoche and Surprise

In writing her haiku, and the essay that traces its evolution, Stegall was searching for an evocative phrase to represent her experience of "feminine physics." What she created was a *synecdoche*, which is a literary term for a figure of speech that uses a representative term to express a whole--for example, *head* for cattle, or *hands* for workers. "All hands on deck," for instance, is a synecdoche commanding every sailor to report to duty; calling those same men "old salts" alludes to the larger brine in which their ship sails. When Stegall chose "apple" to evoke the history of Newton's experiments with gravity, she was constructing a synecdoche in accord with the same logic: using a part to call to mind the whole.

It is our claim here that the creative aspects of intellectual activity involve similar acts of synecdoche: constituted either by a gesture that names a whole in terms of one of its parts, or by one that identifies a part in terms of its whole. What is key in this understanding, and key to our understanding of the usefulness of transdisciplinary work, is the underdetermined and non-congruent nature of this relationship: the part, or representation, will never reflect or encompass the whole of an event.

Literary critics understand synecdoche (and its variants, *metaphor* and *metonymy*) not as reliably representing any whole, but rather only--and often times deliberately--selected aspects of it. Synecdoche is always "value constituting" (Richardson, 1997, p. 45); any synecdoche frames our understanding in a "distinctive yet partial" way (Morgan, 1986, p. 13). Working within the synecdochal presumptions of a single discipline, however, we may sometimes forget the limited and unreliable nature of our representations. Working within scientific disciplines that emphasize the discovery of the predicted, for instance, we might be particularly likely to miss seeing the unpredicted.

Thinking synecdochally also highlights the commonality between quantitative and qualitative inquiry. Scientists may study a part in order to understand the whole, with a sample standing in for a larger population. Humanists may use a whole to represent a part, using generic conventions, for example, to interpret a particular work of art. All inquirers are searching for a good theory that is capable of making sense of available representative data.

In *Once Upon a Number*, mathematician John Paulos (1998) describes the gap between stories and statistics as a synecdoche for the better-known gap between literary and scientific cultures. He suggests that the world is a contest between *complicators* (humanists, storytellers) and *simplifiers* (scientists, statisticians)--also known as *lumpers* and *splitters* (Paulos, 1998, p. 16). Instead, we see the relation between humanists and scientists as a collaborative rather than a

competitive enterprise, and recognize both complexification and simplification as activities that operate across all disciplines.

There is of course a long-standing debate about whether meaning is best made by lumping or by splitting, a debate that recalls the distinction between inducing patterns from observations and deducing consequences from starting postulates. Our own perspective is that knowledge is made by a *reciprocal loop* between induction and deduction (Dalke, Grobstein, & McCormack, 2006, Figure 1). Newton built his theory of gravity out of known facts about the behavior of material bodies. Einstein reversed the procedure, adopting certain principles of invariance, from which he then derived the laws of relativity. But neither Newton nor Einstein simply induced or deduced; each induced an alternative and then deduced its implications.

7. Maximizing Serendipity

The reason that knowledge is generated in such looping action between parts and wholes is that both our brains (as Stegall's creation of surprising new images suggests) and the world (as quantum physics and complexity theory tell us) are inherently underdetermined. Further, multiple interpretations are always available, both for words and things. There is never only one way to represent what happens or one way to interpret that representation.

Feminist theorists have long argued for the situatedness of knowledge; they have advanced multiple, compelling arguments for the need to be politically aware of the epistemic injustice of excluding particular points of view, and the epistemic advantage of including them (see, for example, Barad, 1996; Haraway, 1988; Harding, 1991; Keller, 1985; Longino, 1990; Wylie, 2003). Our claim here adds another dimension to this argument, one that draws on contemporary understandings about the biological variability of brain function (Grobstein, 1994). On a larger scale, it might be said to be evolutionary, in accordance with contemporary theories of *emergence*, in which unpredictability and complexity arise out of the repeated action of a simple set of rules (cf. Center for Science in Society, 2006). There is of course a long tradition in philosophy recognizing "the limitations of inductive thought" and "impossibility of deriving universals from collections of observations":

> It is not only that universals require an infinite number of observations, but also that any finite set of observations is consistent with multiple conceivable universals . . . the organization of the brain is such that it itself contains, at any given time, not one set of understandings but a variety of them. . . . If there exist non-deterministic process in the world, it follows that conclusions made inductively from observations must always be held tentatively since an inconsistent future observation is always possible. Similarly, any conclusions based on reduction of observations to date to "first principles" and deduction needs also to be understood as subject to reconsideration and revision. (Grobstein, 2007a; see also Grobstein, 2007b)

In *The Black Swan: The Impact of the Highly Improbable*, a contemporary book exploring how we might better handle the increasingly unpredictable world in which we find ourselves, Nassim Taleb argues that our human insistence on reducing the dimensions of complexity, imposing

order on chaos, and identifying causes for the effects we observe around us can--increasingly does--have explosive consequences. This urge to simplify "rules out sources of uncertainty and drives us to a misunderstanding of the fabric of the world" (Taleb, 2007, p. 16). Given the high impact of the highly improbable, we need to cultivate much more skeptical empiricism; that is, to resist the tendency to make generalizations based on limited observations. Many of Taleb's exhortations accord with those that are repeatedly explored, often advocated, in science classes: "Doubt everything." "Fight against dogma." Shed the idea that linear predictable phenomena are the norm. Most striking, though, is his insistence that we can benefit from the unpredictability of the world, if we are willing to "maximize the serendipity" around ourselves (Taleb, 2007, p. 204).

It is our argument here that transdisciplinary work is indeed a very effective way of maximizing serendipity. It is also a way of answering the now decades-old request of Evelyn Fox Keller that we "formulate a cognitive paradigm adequate" to our contemporary engagement with and comprehension of the world. "What is required," Keller insists, "is a paradigm that . . . acknowledges the inevitable interaction between knower and known, and . . . respects the equally inevitable gap between theory and phenomenon" (Keller, 1985, p. 139).

The first aspect of the unpredictable nature of the project of constructing knowledge is that the action of the knower alters what we know. The second is that the interpretations available to us as knowers are always multiple, always various. It is because of these two forms of unpredictability that transdisciplinary work--which keeps unsettling assumptions about what counts, what should be foregrounded, what needs to be attended to--can be so generative.

Elsewhere in this issue, across a range of different cuts, contributors identify useful distinctions among extra-, trans-, bridging, multi-, cross-, and inter-disciplinary practices. Our own claim for transdisciplinary knowledge production foregrounds the shattering of conventional wholes. The observer experiences the fluidity of boundaries between herself and the world. Dualisms break down, as one-to-one correspondences between paired concepts prove inadequate. Parts and wholes are not necessarily congruent, and the moves between them are underdetermined. We have learned from experience how the transdisciplinary activities of breaking down and reconstructing ideas can result in surprising and innovative ways of making sense of the world.

Acknowledgements

We thank our students--Rebecca Donatelli, Sam Knapp, Rosemary Malfi, Liz Newbury, Odile Schalit, Flora Shepherd, Sky Stegall, and Alex Tisman--who helped us to these understandings; the three thoughtful reviewers of an earlier version of this essay, who helped us to revise them; and the Center for Science in Society at Bryn Mawr, USA, which has supported so much of this work.

References

Barad, K. (1996). Meeting the universe halfway: Realism and social constructivism without contradiction. In L. H. Nelson & J. Nelson (Eds), *Feminism, science, and the philosophy of science* (pp. 161-194). London: Kluwer Academic.

Barad, K. (2000). Reconceiving scientific literacy as agential literacy: Or, learning how to intra-act responsibly within the world. In R. Reid & S. Traweek (Eds), *Doing science + culture* (pp. 221-258). New York: Routledge.

Center for Science in Society. (2006). *Emergent systems: A discussion*. Retrieved October 31, 2007, from http://serendip.brynmawr.edu/local/scisoc/emergence

Cook-Sather, A., & Shore, E. (2007). Breaking the rule of discipline in interdisciplinarity: Redefining professors, students, and staff as faculty. Journal of Research Practice, 3(2), Article M15. Retrieved October 31, 2007, from http://jrp.icaap.org/index.php/jrp/article/view/101/93

Dalke, A., Grobstein, P., & McCormack, E. (2006). Exploring interdisciplinarity: The significance of metaphoric and metonymic exchange. Journal of Research Practice, 2(2), Article M3. Retrieved October 31, 2007, from http://jrp.icaap.org/index.php/jrp/article/view/43/54

Gould, S. (1996). *The mismeasure of man*. New York: W. W. Norton.

Grobstein, P. (1994). Variability in brain function and behavior. In V. S. Ramachandran (Ed.), *The encyclopedia of human behavior* (Volume 4, pp. 447-458). San Diego, CA: Academic.

Grobstein, P. (2007a). *Paths to story telling as life: Fellow traveling with Richard Rorty*. Retrieved October 31, 2007, from http://serendip.brynmawr.edu/exchange/rorty

Grobstein, P. (2007b). Interdisciplinarity, transdisciplinarity, and beyond: The brain, story sharing, and social organization. Journal of Research Practice, 3(2), Article M21. Retrieved October 31, 2007, from http://jrp.icaap.org/index.php/jrp/article/view/98/92

Grosz, E. (1993). Bodies and knowledges: Feminism and the crisis of reason. In L. Alcoff & E. Potter (Eds), *Feminist Epistemologies* (pp. 187-215). New York: Routledge.

Harding, S. (1986). *The science question in feminism*. Ithaca, NY: Cornell University Press.

Harding, S. (1991). *Whose science? Whose knowledge?* Ithaca, NY: Cornell University Press.

Haraway, D. (1988). Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist Studies, 14*(3), 575-599. Reprinted in E. F. Keller & H.

Longino (Eds) (1996), *Feminism and science* (pp. 249-263). New York: Oxford University Press.

Keller, E. F. (1985). *Reflections on gender and science*. New Haven, CT: Yale University Press.

Longino, H. (1990). *Science as social knowledge*. Princeton, NJ: Princeton University Press.

Lukacs, J. (1994). Heisenberg's recognitions: The end of the scientific world view. *Historical consciousness: The remembered past* (3rd ed., pp. 278-288). New Brunswick, NJ: Transaction. Reprinted 2001, in M. Lederman & I. Bartsch (Eds), *The gender and science reader* (pp. 225-230). New York: Routledge.

Morgan, G. (1986). *Images of organization*. Beverly Hills, CA: Sage.

Paulos, J. (1998). *Once upon a number: The hidden mathematical logic of stories*. New York: Basic Books.

Pinker, S., & Spelke, E. (2005, April 22). *The science of gender and science* [Transcript]. Debate conducted by Mind/Brain/Behavior Interfaculty Initiative at Harvard University, Cambridge, MA. Retrieved October 31, 2007, from Edge: The Third Culture Web site: http://www.edge.org/3rd_culture/debate05/debate05_index.html

Richardson, L. (1997). *Fields of play: Constructing an academic life*. New Brunswick, NJ: Rutgers University Press.

Stegall, M. (2007). *Apple blossom journey: A path to feminizing physics*. Unpublished manuscript, Bryn Mawr College, PA.

Taleb, N. (2007). *The black swan: The impact of the highly improbable*. New York: Random House.

Tong, R. P. (1998). *Feminist thought: A more comprehensive introduction* (2nd ed.). Boulder, CO: Westview.

Wylie, A. (2003). Why standpoint matters. In R. Figueroa & S. Harding (Eds), *Philosophical explorations of science, technology, and diversity* (pp. 26-48). New York: Routledge.

Received 24 May 2007

Accepted 21 September 2007